Mass Customization: Sustainability of a Computer-Based Manufacturing System

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1 Introduction

The issue of mass customization becomes increasingly meaningful to the global economy. Whether cars or cereals, shampoos or sneakers: not only small start-ups but also global companies such as Adidas and Coca-Cola follow this trend. Is this only hype or actually a business model for the future? The second question is about the sustainability of mass customization. The third question concerns the role of the information and communication technology (ICT) with both the realization of mass customization and the realization of a sustainable mass customization.

2 Mass Customization

Mass customization is a concept introduced by Stanley M. Davis in 1987. Traditional industrial production is using economies of scale to produce goods at low costs. This is called mass production. Mass production has nearly no variety (for example the Ford T Model). In contrast, individual production with a high degree of variety has small volumes with high costs. Davis suggested that new business models should accept "the coexistence of mutually contradictory phenomena" (Davis 1989) and he called this business model "mass customization". Mass customization is realizable through the use of new technology that offers both economies of scale and specificity. The goal is to produce goods that are individually and cost-effectively manufactured. Besides questions of manufacturing, the customer's

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awareness and perception of mass customization is mentioned as another prerequisite of the concept (Davis 1989).

A very common definition of mass customization is that it refers to the production of products and services for a (relatively) large market, which meets the different needs of each customer of these products, with the efficiency of a comparable mass or series production (Piller 2006). According to this definition, the following four aspects of mass customization should be considered (Piller 2004):

- **Customer Co-Design**: The genus of mass customization is customer co-design (Piller 2004). Customers are integrated into the product and service creation by defining and configuring an individual solution. It is a concretization of the end user desires and needs to certain product specifications. For this procedure, the end user needs a tool, e.g., a paper-based catalog or configuration software (Boër et al. 2013).
- **The Needs of Each Individual Customer**: The co-design procedure provides all possible product configurations offered by the manufacturer (degree of customization). The goal of mass customization is a single customized product, which correctly identifies the customization dimensions and options meant to satisfy the customer needs. These individual needs can be operationalized by the following three dimensions (Boër et al. 2013):
  - *Fit*: measurements of a product with the given dimensions of the recipient
  - *Style*: aesthetic design by modifications aiming at optical or sensual senses
  - *Functionality*: technical attributes (power, interfaces etc.) of an offering.

  A three-branch radar graph depicts these dimensions of customization (see Fig. 1).

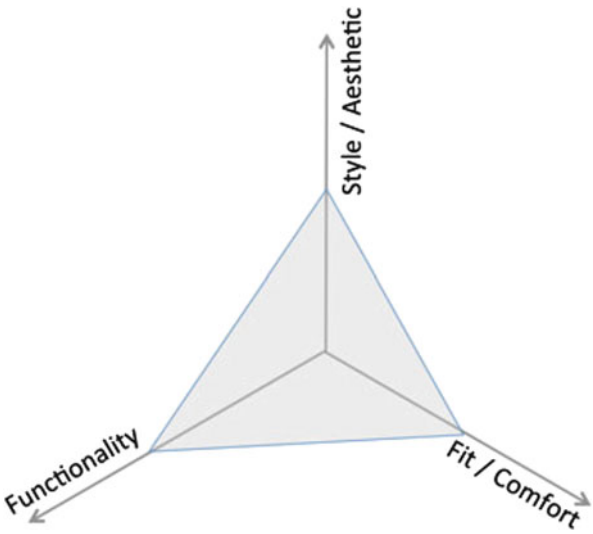

Fig. 1 The customization axes (Boër et al. 2013)

- **Stable Solution Space**: A solution space can be defined as pre-existing capability and degrees of freedom built into a given manufacturer's production system (Von Hippel 2001). Therefore, a successful mass customization system is characterized by *stable* but still flexible and responsive processes that provide a dynamic flow of products (Piller 2004). While within a conventional (craft) customization the customizer re-invents not only its products but also its processes for each individual customer, a mass customizer uses stable processes to provide high-variety products and services.
- **Adequate Price**: Mass customization can be distinguished from craft customization by the fact that mass-customized products and services are targeting the same market segment like the markets of corresponding standard products and services. In contrast, the traditional craft customization is located in the premium price segment. Therefore, the targets of craft customization are completely different market segments.

In the field of environmental sustainable mass customization research, one basic question is whether "mass-customized products [are] more sustainable or less sustainable compared to traditionally mass produced products" (Brunø et al. 2013). Methods used for this kind of research question usually focus on the difference of modular products (mass customization) and integrated products (traditional mass production). Initially, it is assumed that integrated products have the advantage that "the performance of a product can be improved compared to a modular product" (Brunø et al. 2013).

Research results (Brunø et al. 2013) point out that there are several relations between the elements of mass customization and environmental sustainability. Typical concepts, which have an impact on the performance of mass customization, are:

- Individual distribution
- Modularity
- Process variety
- Product variety
- Reconfigurability.

All these concepts have an effect on the following indicated elements of environmental sustainability in the context of mass customization:

- Energy efficiency
- Material usage
- Process variety
- Need for additional products
- Reuse
- Remanufacturing
- Enables upgrades
- Service
- Premature disposal

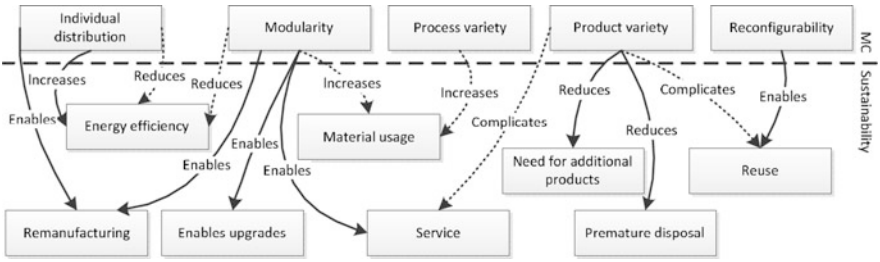

Fig. 2 Relations between mass customization and sustainability (Brunø et al. 2013)

Concerning the element of energy efficiency, the concept of individual distribution potentially has a positive influence (solid line in Fig. 2) and a negative influence (dotted line in Fig. 2) on the environmental sustainability compared to mass production. Furthermore, individual distribution enables remanufacturing (positive effect on environmental sustainability). The concept of modularity has negative effects on the energy efficiency and material usage (both dotted lines in Fig. 2) and positive effects on remanufacturing, enables upgrades and service (solid lines in Fig. 2). The concept of process variety increases the material usage (negative effect, dotted line in Fig. 2). The concept of product variety complicates the elements service and reuse (negative effects, dotted lines in Fig. 2) and reduces the need for additional products as well as the premature disposal (positive effects, solid lines in Fig. 2). Finally, the concept of reconfigurability enables reuse (positive effect, solid line in Fig. 2).

This qualitative study concludes that eight positive and six negative relationships were identified. However, these numbers cannot be used for concluding that mass customization is more sustainable than mass production, since these relations are not unambiguously quantifiable and can only be quantified for specific products as different products have different environmental impacts. Furthermore, the authors of the study state that further research could analyze these relations using a quantitative approach for specific product types (Brunø et al. 2013).

The qualitative study of Brunø et al. (2013) points out positive and negative relations between mass customization and sustainability, but provides no starting point for an approach of sustainable mass customization. Thinking about (more) sustainability in the context of mass customization, the main connecting factor is the aspect *customer co-design* in conjunction with the aspect *needs of each individual customer*.

3 Customer Co-design as Connecting Factor of Sustainability

The customer is of particular importance to mass customization. The basis of the value-added process is the co-design process for the definition of individual goods and services in interaction between providers and users (Piller 2006). Therefore, the customers must be involved in the product design process so that a specific product is produced that meets their needs and requirements.

The basic idea is that the customer co-design process is performed based on a list of options and predefined components. This list is the result of surveys and analyses (aspect *needs of each individual customer*) before the customization process. "Those options were defined trying to meet the needs of the individual customer by analyzing the needs of the many." (Boër et al. 2013). Keeping the thesis "identifying the needs of the individual customer by analyzing the needs of the many" guides us to one fundamental question of design, especially in the context of sustainability:

> Is analyzing the needs of the many able to identify the best and sustainable solution space for mass customization?

A wrong solution space leads us to what the former chief designer of Braun GmbH, Dieter Rams, calls "the arbitrariness and the thoughtlessness with which many products are designed today" (Hein 2015) such that resources are wasted. In his "ten principles for good design" (Vitsoe 2015) Rams states that:

- **Good design is long-lasting** (principle 7): "It avoids being fashionable and therefore never appears antiquated. Unlike fashionable design, it lasts many years—even in today's throwaway society".
- **Good design is environmentally friendly** (principle 9): "Design makes an important contribution to the preservation of the environment. It conserves resources and minimizes physical and visual pollution throughout the lifecycle of the product."

Therefore, the question of how to implement the customer co-design process of mass customization towards sustainability is also a question of how to achieve good design. More precisely: Is the mass able to generate individual and sustainable customer demands or would it be better if the designer creates appropriate options for individual customers? Furthermore, are the customization axes style/aesthetic, fit/comfort and functionality of the mass customization aspect "the needs of each individual customer" the right dimensions for a sustainable mass customization? In detail: Is a single customer able to enumerate in advance their needs of functionality, style/aesthetic and comfort, e.g., for a new car like the new Volkswagen Golf model, in the distant future? The personal fit belonging to the individual bodily space circumstances is the exception. For example, the mass-customized fit of a sport shoe is certainly an interesting factor. But the decision of shoe color and shoe

pattern is not a question of personal fit. In order to not displease the latest fashion trends, the customer needs certain design proposals from the shoe designers.

Design is always to be seen in the relationship of a certain technology and appropriate markets and is never to be seen as a scope in itself (like artists do). The Grand Management Information Design is an approach that deals with these three aspects of design, technology and markets towards sustainable solutions.

4 Grand Management Information Design

Basically every production of goods and services is imaginable as mass customization. If and when a specific goods or service can actually be realized as mass customization depends on the realized or realizable combination of design, technology and market. In 2005, the company Braun GmbH, which belongs to the US company Procter & Gamble, described this approach as "Grand Design", which (at that time for physical products) raises the aspects of design and technology so that new markets can be created and developed, respectively.

A good example of this approach is Apple's iPad (which is in line with Braun's design tradition) that was introduced by Steve Jobs in 2010. Lots of individual manufacturers (including Apple) started several attempts in the field of tablet computers with first experiments in design, technology and market penetration of tablet computers. Though, it is the special combination of design, technology and market response to the iPad, which succeeded.

Our Grand Management Information Design approach is based on the idea of Braun's Grand Design. The goal of Grand Management Information Design is to support the users of ICT with sustainably designed equipment according to their sustainable needs (see Fig. 3). Apple's iPad underlines the purposes of Grand Management Information Design (Arndt 2014):

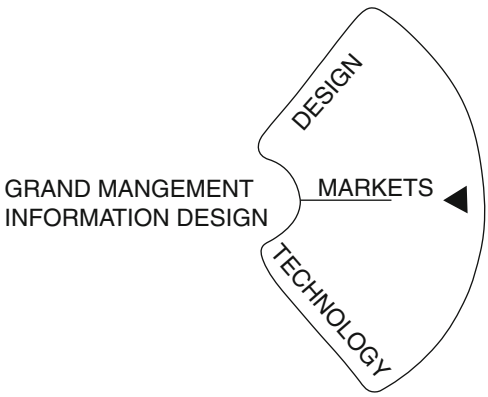

Fig. 3 Grand Management Information Design

- **Design**: The technical quality of the iPad significantly expresses the elegance of both hardware and user interface (software).
- **Technology**: The iPad has significantly increased the technical quality of mobile end devices with touch screens.
- **Market**: Despite initial skepticism, the iPad has succeeded in creating a new market of utmost importance.

In order to achieve an environmental and sustainable **design** of ICT ecosystems, we first have to look at the design process of Apple. While Apple traditionally focuses on ideas and intuition of a visionary designer, in the past the competitor Microsoft developed new products and services by analyzing the—hardly clearly articulated—demands of many and by testing usability in large scale (Arndt 2013). The former Microsoft design approach is very similar to the *needs of the many approach* stated in the context of mass production (see above). According to the ten principles of Rams, good design is the key to greater environmental friendliness and sustainability of products. This also applies to ICT products and ICT ecosystems. The chance to achieve a continuously good design is much higher using the Apple design approach than using the former Microsoft approach.

The question of **technology** can also be explained by one of the ten principles of good design of Rams. In principle 1 "Good design is innovative" (Vitsoe 2015), Rams states: "The possibilities for innovation are not, by any means, exhausted. Technological development is always offering new opportunities for innovative design. But innovative design always develops in tandem with innovative technology, and can never be an end in itself."

The iPad exemplifies the question of **market**. When the iPad was introduced in 2010, the people asked if a device like an iPad is really essential. Is there a significant added value by using such a device? Does the iPad have specific functions that differ from other tablet computers? (Arndt et al. 2013). In an interview with the French Online Service Buzz Média Orange-Le Figaro a Swiss publisher said that the iPad is not more than dalliance (Haymarket Media 2010). Media journalist Jeff Jarvis explained why he returned his iPad to the store (Höly 2010): "I'm taking my iPad back to the store [. . .]. It's really because I don't see a need for it. It's solving a problem that I don't think exists [. . .]." In contrast, in 2010, a few months after the release of the first iPad, Steve Jobs predicted that tablet computers would eventually overtake Personal Computers (PCs). "In 2014, according to updated figures from Gartner, after five years of rather crazy tablet growth and slowly declining PC sales, 2015 will be the year that Jobs' post-PC dream is finally realized. In 2015, Gartner predicts a total of 320 million tablet sales versus only 316 million PC sales (desktops and laptops)" (Anthony 2014). Steve Jobs created a new and very important market in the ICT area with tablet computers.

5 Mass Customization: A Computer-Based Manufacturing System and a Manufacturing System for Information and Communication Technology

Modern business and industrial concepts can only be realized if suitable information and communication technology is available and new ICT leads to new opportunities in business and industry. Therefore, the idea of mass customization can only be achieved as a computer-based manufacturing system, and ICT products can also be manufactured as mass-customized products.

Today, Apple's iPad is still not a product which is attributable to mass customization. But we can see that Apple makes significant steps towards diversification. The iPhone is now available in two sizes (iPhone 6 and the larger iPhone 6S) and more than the original two color versions (three for iPhone 6 and 6S, and even five colors for iPhone 5C). Diversification leads to mass customization. However, at which point exactly this step is taken away from the industrial mass production towards mass customization is only decided by the respective realizable or realized combination of design, technology and market.

The Internet plays a crucial role in mass customization. More generally, it may not only be the Internet, but a corresponding information and communication platform. On the customer side, product configurations can be realized with the help of the Internet, i.e., realizing the front end of mass customization, and the Internet transports the user interface to the customer. In the background, the communication along the value chain or rather value network of customized products is based on the Internet as well (supply chain management).

New ICT will always lead to new opportunities for products and services. For example, the 3D printer will lead to acceleration effects in mass customization, but the exact amount is difficult to predict. Certainly, time savings, such as for the development of new products, are possible. And of course, the 3D printer will lead to new applications of mass customization. A mass customization is always limited. But these limits are not fixed in the course of time, they are continuously changing.

Certainly, there are specific limits of extra charges caused by mass customization. Today, it is difficult to imagine that products, which you can buy in five-and-dimes, were produced in terms of mass customization. But who says that this fact will be valid forever—particularly for companies that are competing in our globalized economy? Especially with 3D printers it is possible to think about an implementation of mass customization by printing cheap products on-site in five-and-dimes in the future. However, this vision may cause large negative environmental impacts. Therefore, design, technology and market must be considered in a synopsis to achieve successful and sustainable ICT products and ICT-based solutions such as mass customization.

6 Mass Customization and Sustainability

ICT represents a key technology that helps to offer continuously new and ever more individualized services on the market. Mass customization leads to diversification and vice versa. Diversification—at least in a company—is limited. In this context, the keyword *core competencies* is important. Companies have only limited core competencies available in a certain time. The designer Dieter Rams states that leaving the company's core competencies leads to arbitrariness, which is dangerous for the long-term success in the market. Furthermore, arbitrariness is contrary to the sustainable and respectful use of resources and causes negative environmental impacts.

However, the inexactly determinable boundary between industrial mass production and individualized mass customization has to be approximately identified in each period. This boundary is influenced by the kind of product (e.g. automotive industry) or service. Premium products are rather subject to mass customization than volume products (especially observable in the automotive sector). Each time has a price-based limit for mass customization, but with a certain combination of design, technology and market there is and will be a move away from premium products to volume products. One the other hand, the opportunities of customization of premium products will always be far greater than the opportunities of customization of volume products.

A particular manner of handling the question of sustainability and mass customization is an approach which addresses the link between mass customization and sustainability by defining a set of key performance indicators (KPIs) such as the sustainability assessment model (SAM) (Boër et al. 2013) or the Mass Customization Business Model (MC BM): The "development of an MC BM provides the required backbone to analyze the environmental impacts of such a BM. In other words, we can monitor the performance of the MC BM in terms of environmental sustainability to understand 'Is mass customization is sustainable?'. In order to track the possible impacts, three KPI are defined in this study: waste production, energy consumption and emission" (Pourabdollahian et al. 2014). More generally, "providing customers with enough information on the environmental impact of certain product attributes during the co-design process can help the users to understand the sustainability impact of their individual choices and thus ultimately supports the design of more ecofriendly products" (Pourabdollahian and Steiner 2014).

Though, we must state that the simple addition of KPIs to the concept of mass customization is far from being a sustainable mass customization. In order to achieve a sustainable mass customization, we need an operationalization of the Grand Management Information Design approach. A core point of the Grand Management Information Design approach and the concept of mass customization is the **design** of products and services. Design is always to be seen in the relationship of a certain technology and appropriate markets, operationalized by the ten principles of good design of Dieter Rams (Vitsoe 2015):

1. **Good design is innovative:** The possibilities for innovation are not, by any means, exhausted. Technological development is always offering new opportunities for innovative design. But innovative design always develops in tandem with innovative technology, and can never be an end in itself.
2. **Good design makes a product useful:** A product is bought to be used. It has to satisfy certain criteria, not only functional, but also psychological and aesthetic. Good design emphasizes the usefulness of a product whilst disregarding anything that could possibly detract from it.
3. **Good design is aesthetic:** The aesthetic quality of a product is integral to its usefulness because products we use every day affect our person and our well-being. But only well-executed objects can be beautiful.
4. **Good design makes a product understandable:** It clarifies the product's structure. Better still, it can make the product talk. At best, it is self-explanatory.
5. **Good design is unobtrusive:** Products fulfilling a purpose are like tools. They are neither decorative objects nor works of art. Their design should therefore be both neutral and restrained, to leave room for the user's self-expression.
6. **Good design is honest:** It does not make a product more innovative, powerful or valuable than it really is. It does not attempt to manipulate the consumer with promises that cannot be kept.
7. **Good design is long-lasting:** It avoids being fashionable and therefore never appears antiquated. Unlike fashionable design, it lasts many years—even in today's throwaway society.
8. **Good design is thought-out to the last detail:** Nothing must be arbitrary or left to chance. Care and accuracy in the design process show respect towards the user.
9. **Good design is environmentally friendly:** Design makes an important contribution to the preservation of the environment. It conserves resources and minimizes physical and visual pollution throughout the lifecycle of the product.
10. **Good design is as little design as possible:** Less, but better—because it concentrates on the essential aspects, and the products are not burdened with non-essentials. Back to purity, back to simplicity.

Therefore, these ten principles of good design should consequently be applied to the concept of mass customization. And of course, during the design process and all other processes of mass customization sustainable KPIs are needed. But it must be kept in mind that some of these KPIs are measurable and some are not. The Global Reporting Initiative (GRI) guidelines for sustainable reporting provide a good overview of potential sustainability performance indicators, which are organized by economic, environmental and social categories (GRI 2011):

- Economic Performance Indicator:
  - Aspect: Economic Performance (4 indicators)
  - Aspect: Market Presence (3 indicators)
  - Aspect: Indirect Economic Impacts (2 indicators)

- Environmental Performance Indicators:
  - Aspect: Materials (2 indicators)
  - Aspect: Energy (5 indicators)
  - Aspect: Water (3 indicators)
  - Aspect: Biodiversity (5 indicators)
  - Aspect: Emissions, Effluents, and Waste (10 indicators)
  - Aspect: Products and Services (2 indicators)
  - Aspect: Compliance (1 indicator)
  - Aspect: Transport (1 indicator)
  - Aspect: Overall (1 indicator)
- Social Performance Indicators:
  (a) Labor Practices and Decent Work Performance Indicators:
    - Aspect: Employment (4 indicators)
    - Aspect: Labor/Management Relations (2 indicators)
    - Aspect: Occupational Health and Safety (4 indicators)
    - Aspect: Training and Education (3 indicators)
    - Aspect: Diversity and Equal Opportunity (1 indicator)
    - Aspect: Equal Remuneration For Women And Men (1 indicator)

  (b) Human Rights Performance Indicators:
    - Aspect: Investment and Procurement Practices (3 indicators)
    - Aspect: Non-discrimination (1 indicator)
    - Aspect: Freedom of Association and Collective Bargaining (1 indicator)
    - Aspect: Child Labor (1 indicator)
    - Aspect: Forced and Compulsory Labor
      Core (1 indicator)
    - Aspect: Security Practices (1 indicator)
    - Aspect: Indigenous Rights (1 indicator)
    - Aspect: Assessment (1 indicator)
    - Aspect: Remediation (1 indicator)

  (c) Society Performance Indicators:
    - Aspect: Local Communities (3 indicators)
    - Aspect: Corruption (3 indicators)
    - Aspect: Public Policy (2 indicators)
    - Aspect: Anti-Competitive Behavior (1 indicator)
    - Aspect: Compliance (1 indicator)

  (d) Product Responsibility Performance Indicators:
    - Aspect: Customer Health and Safety (2 indicators)
    - Aspect: Product and Service Labeling (3 indicators)
    - Aspect: Marketing Communications (2 indicators)
    - Aspect: Customer Privacy (1 indicator)
    - Aspect: Compliance (1 indicator)

7 Conclusion

The goal of Grand Management Information Design is to support the concept of mass customization with sustainable products and services according to the sustainable needs of end users. Therefore, in the context of mass customization the implementation of customer co-design is always to be seen as a sustainable pre-design of an expert in the relationship of a certain technology and appropriate markets. KPIs are not the key to an approach of sustainable mass customization. After all, we have highlighted that KPIs in this respect are merely a supplement of design—but a reasonable one.

References

Anthony S (2014) In 2015 tablet sales will finally surpass PCs, fulfilling Steve Jobs' post-PC prophecy. http://www.extremetech.com/computing/185937-in-2015-tablet-sales-will-finally-surpass-pcs-fulfilling-steve-jobs-post-pc-prophecy. Accessed 22 Mar 2015

Arndt H-K (2013) Umweltinformatik und Design—Eine relevante Fragestellung? In: Horbach M (ed) INFORMATIK 2013: Informatik angepasst an Mensch, Organisation und Umwelt. 43. Jahrestagung der Gesellschaft für Informatik, Koblenz, Sept 2013. Gesellschaft für Informatik, vol P-220, Bonner Köllen Verlag, pp 931–939

Arndt H-K (2014) Big data oder grand management information design? In: Plödereder E, Grunske L, Schneider E, Ull D (eds) INFORMATIK 2014: Big data—Komplexität meistern. 44. Jahrestagung der Gesellschaft für Informatik, Stuttgart, Sept 2014. Gesellschaft für Informatik, vol P-232, pp 1947–1956

Arndt H-K, Mokosch M, Pleshkanovska R (2013) iPad—an environmental-friendly working tool? In: Page B, Fleischer AG, Göbel J, Wohlgemuth V (eds) EnviroInfo 2013: environmental informatics and renewable energies. 27th conference on environmental informatics—informatics for environmental protection, sustainable development and risk management, Hamburg, Sept 2013. Shaker Verlag, Aachen, pp 492–502

Boër CR, Pedrazzoli P, Bettoni A, Sorlini M (2013) Mass customization and sustainability: an assessment framework and industrial implementation. Springer, London

Brunø TD, Nielsen K, Taps SB, Jørgensen KA (2013) Sustainability evaluation of mass customization. In: Prabhu V, Taisch M, Kiritsis D (eds) Advances in production management systems: sustainable production and service supply chains. IFIP WG 5.7 international conference, APMS 2013, State College, Sept 2013. IFIP advances in information and communication technology, vol 414. Springer, Heidelberg, pp 175–182

Davis SM (1989) From "future perfect": mass customizing. Strateg Leadersh 17(2):16–21

GRI (2011) Sustainability reporting guidelines. https://www.globalreporting.org/resourcelibrary/G3.1-Guidelines-Incl-Technical-rotocol.pdf. Accessed 22 Mar 2015

Haymarket Media (2010) Auch Michael Ringier hält den Ball flach: "Das iPad ist bislang nur eine Spielerei". http://kress.de/mail/tagesdienst/detail/beitrag/104288-auch-michael-ringier-haelt-denball-flach-das-ipad-ist-bislang-nur-eine-spielerei.html. Accessed 22 Mar 2015

Hein B (2015) Design guru Dieter Rams says Apple built his dream PC. http://www.cultofmac.com/316222/design-guru-dieter-rams-says-apple-built-his-dream-pc/. Accessed 22 Mar 2015

Höly D (2010) Steve Jobs und das iPad: Kein Messias und nur eine Maschine (3). https://juiced.de/6005/steve-jobs-und-das-ipad-kein-messias-und-nur-eine-maschine-3/. Accessed 22 Mar 2015

Piller FT (2004) Mass customization: reflections on the state of the concept. Int J Flex Manuf Syst 16(4):313–334

Piller FT (2006) Mass Customization: Ein wettbewerbsstrategisches Konzept im Informationszeitalter. Deutscher Universitätsverlag, Wiesbaden

Pourabdollahian G, Steiner F (2014) Environmental and social impacts of mass customization: an analysis of beginning-of-life phases. In: Grabot B, Vallespir B, Samuel G, Bouras A, Kiritsis D (eds) Advances in production management systems. Innovative and knowledge-based production management in a global-local world. IFIP WG 5.7 International Conference, APMS 2014, Ajaccio, Sept 2014. IFIP advances in information and communication technology, vol 439. Springer, Heidelberg, pp 526–532

Pourabdollahian G, Taisch M, Piller, FT (2014) Is sustainable mass customization an oxymoron? An empirical study to analyze the environmental impacts of a MC business model. In: Brunoe TD, Nielsen K, Joergensen KA, Taps SB (eds) Proceedings of the 7th world conference on mass customization, personalization, and co-creation, Aalborg, Feb 2014. Lecture notes in production engineering. Springer, pp 301–310

Vitsoe (2015) Dieter Rams: ten principles for good design. https://www.vitsoe.com/gb/about/good-design. Accessed 22 Mar 2015

Von Hippel E (2001) PERSPECTIVE: user toolkits for innovation. J Prod Innov Manag 18(4): 247–257